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BIPOLAR SYNERGIES: THE ROLE OF DIACHRONIC AND SYNCHRONIC STUDY OF WORDS IN CONTENT COMPREHENSION AT TERTIARY LEVEL

Abstract

The present study was conducted to investigate the use of etymology and semantic grouping as cognitive vocabulary learning strategies in professional colleges like engineering colleges to enhance the L2 learners' reading comprehension of academic texts. Despite a plethora of research in ESP, specific vocabulary learning strategies in relation to multilingual student population elude ESP practitioners entrusted with the task of providing the learners with enough lexical knowledge to read and understand the textbooks written in English. Hence a diagnostic study was conducted among 370 students of an engineering college in India, a country where students receive school education through 42 languages. Based on the results, an experimental study was conducted among 80 students. The experimental group was provided with vocabulary strategies at cognitive level to enhance reading comprehension. A paired samples t-test was conducted to find the difference in the means of the post-test and the pre-test of the experimental group. The *t*-value was 15.43 and when the standardized difference between the means was calculated in terms of Cohen's *d*, the value was 2.4, which was very large (>0.8). Thus, the study underscored the assumption that more than word meanings, the word meaning processes are causal components of comprehension skill.

Key words

ESP, L2 learners, content vocabulary, cognitive learning, reading.

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1. INTRODUCTION

Words are building blocks of a language and vocabulary plays a significant role in language learning. The vocabulary rich ambience gives native speakers of English the constant exposure to words, which is paramount to enrich their repertoire of vocabulary. Historically, vocabulary and list learning were discredited along with the Grammar Translation method in the early 20th century due to the influence of social, behavioural and psychological theories. The second language acquisition (SLA) theories that evolved later favoured deductive learning, incidental learning, real life learning, communicative learning and community learning, all of which did not give vocabulary its due place. But since the 1960s there has been a revival of interest in vocabulary learning as it is found to play a crucial role in determining the success of reading comprehension (e.g. Anderson & Freebody, 1981, 1983; Nation, 1990, 2001; Laufer, 1996). Alderson (2000: 99) says that "vocabulary plays a very important role in reading tests" and that reading research has "consistently found a word knowledge factor on which vocabulary knowledge loads highly." Perfetti (2007) asserts that skill differences in comprehension arise from skill differences in word reading.

The vital role of vocabulary knowledge in reading comprehension in general has been studied and empirical evidence is available. General vocabulary is different from content vocabulary in two aspects. Content vocabulary is restricted to academic discourse and can be found in mid and low frequency bands only. Secondly, a deep understanding of the word meaning is necessary for reading and comprehending a text; guessing from the context does not help the learners. A deep understanding becomes possible only with the application of mental processes that are consciously implemented to regulate thought processes in order to achieve goals (Cameron & Jago, 2013). This is the crux of cognitive learning that evolved from cognitive psychology, the study of internal processes in human mind associated with processing information. Though cognitive learning strategies are mentioned in Vocabulary Learning Strategies (VLS), they are almost similar to memory strategies. Both focus on repetition and mechanical means of learning rather than mental processing. The current study, however, deals specifically with Cognitive Vocabulary Learning (CVL) involving the diachronic and synchronic study of words using the strategies of etymology, semantic grouping, and use of affixes to improve the content vocabulary of L2 learners in ESP context.

The experimental study was conducted in the field of engineering education which is very popular in India as nearly 1.5 million students enroll in engineering colleges every year. The creation of the Engineering Science Word List (ESWL) from Indian academic corpus by Viswanathan and Sultana (2018) prior to the present study provided the target word list for the current study. The assumption of the present study is that since 60% of words in the English language and 90% of technical words are derived from classical roots of Greek or Latin, the emphasis on learning vocabulary through word families and their roots will expand the students' lexical knowledge by increasing awareness of the morphology of lexical items. The cognitive strategies would enable them to recognize the roots, bases and affixes of newly encountered words and relate them to the words that they already know to understand their meaning. The prior knowledge acts as the schema promoting understanding and comprehending the technical or scientific passages in their textbooks. The study shows the effectiveness of CVL among the students speaking multiple languages as their first language. The significance of the study lies in the fact that the L1 (Tamil/Malayalam/Telugu/Kannada) of the students who have participated in the study belongs to the family of Dravidian languages which have little similarity with the proto Indo European languages or proto Indo Aryan languages. The researcher could not find a single cognate for any of the content words in the L1 of the participants; all the words including the names of elements were new to the students.

2. BACKGROUND AND DIAGNOSTIC STUDY

India is a pluralistic society and Indian classrooms are heterogeneous. According to a report in Narayan (2017), The People's Linguistic Survey of India has come out with a list of 780 languages spoken by Indians, though the Indian Constitution recognizes only 22 of them as official languages, giving the status of national language to none. Policy makers, guided by the views of educationalists, psychologists and UNESCO, advocate the use of mother tongue of the students to be the medium of instruction. As a result, school education is offered through 42 languages and 66.94% students receive education through vernacular medium against 33.06% of students who study in English medium schools (National Council of Educational Research and Training, NCERT, 2018). At the end of school education, nearly 1,565,177 students enroll in 3,348 colleges (All India Council for Technical Education, AICTE, 2018) where English is the compulsory medium of instruction. Hence, the transition from secondary to tertiary level is always traumatic and the students' struggle for academic success has remained a matter of concern for educationalists and classroom teachers. Scholars have indicated that reading skill is vital to academic success, particularly for ESL learners (e.g. Anderson, 2015; Anderson, Evans, & Hartshorn, 2014; Grabe, 2009; Horowitz, 1986). A diagnostic study conducted among seven groups of first year students totaling 370 at the commencement of their course in two consecutive years revealed a gap in learning at secondary level resulting in poor vocabulary and reading comprehension skill at the tertiary level.

The diagnostic test was a combination of vocabulary and reading comprehension tests. The highest score in the test was 88 and the lowest was 0. The mean of the students' vocabulary test score was 40% and the reading comprehension (RC) test score was 40.5%. A questionnaire was also filled by the students who took the test. The analysis of the questionnaire showed that only 48 students had regular reading habits and 24 of them read English newspapers or stories or novels. In vernacular medium schools English is offered as a subject and Communicative Language Teaching (CLT) methodology is practiced in Indian schools. Thus, English textbooks are the only reading materials for the students. Among the vocabulary learning strategies known to them and practiced in schools, etymology and semantic grouping found no place. Students mentioned that they were given either the dictionary meaning or the L1 equivalent of words in schools. A scrutiny of English textbooks of classes I to XII revealed a few random exercises on prefixes and suffixes and nothing on etymology, semantics grouping, word families, interesting facts about the origin and evolution of words and word meanings.

An interesting fact emerged while checking the answers and talking with the students informally during the pilot study. The students who had written '2πr' as the meaning of the word *circumference* could not answer when asked about the formula for measuring the perimeter of a circle because they did not know that *perimeter* of a circle was called *circumference*. They associated the word *perimeter* with other geometric figures and *circumference* with a circle because that was what they had learnt in mathematics. It meant that the orthographic or phonic aspect of a word was registered as a mathematical formula in their mental lexicon and domain specific words meant nothing for them outside the domain. Learning for them was 'rote learning'. The findings reinforced the notion that lack of cognitive learning was undisputedly a major reason for their insufficient word knowledge and poor reading skill.

Therefore, non-native speakers of English at Indian universities and colleges of Science and Technology have insufficient content vocabulary, which impedes their reading comprehension of academic texts. Further, the various dimensions of word meanings are not known to them indicating lack of cognitive learning and their inability to understand and use the words outside the boundaries of domain in which they occur.

The aim of the study was to investigate the use of etymology and semantic grouping as CVL strategies in professional colleges like engineering colleges to enhance the L2 learners' reading comprehension of academic texts. The CVL can be tremendously beneficial to the students as the diachronic perspective of word origin and changes over time give ample scope for creating mental images enabling 'dual coding' and the 'elaborate processing' involved in learning leads to a deeper knowledge of words.

3. LITERATURE REVIEW

3.1. Language theories on reading and vocabulary

Reading is a skill and good readers learn or acquire the subskills needed to master comprehension. Different theories on reading emphasize different subskills and weigh one against others. The traditional view focused on the text and according to Dole, Duffy, Roehler, and Pearson (1991) readers acquire a set of hierarchically arranged subskills which sequentially build toward comprehension ability. In 'bottom-up' model readers are mere recipients of information that is equivalent of written symbols (Nunan, 1991). The 'top-down' model is just the contrast of the 'bottom-up' model and it is in concordance with the psycholinguistic model, according to Nunan (1991). In the 'interactive' model supported by the cognitive theory of reading, the focus is on the interactive nature of reading where readers play an active role in deciphering information by psycholinguistic guessing, using schemata to interpret sensory data and adapting suitable strategies to comprehend a text. In metacognitive view, the control the readers execute on their strategies to understand the text is given focus. The three theories of reading comprehension put forward by Gunning (1996) namely, the Schema Theory, the Mental Models and the Propositional Theory also are reflections of the cognitive theory. Learners who obtain incomplete comprehension of the passage due to their struggle with word recognition often end up memorizing the words including spellings and the whole sentences to get the required grades as observed in the pilot study. However, for meaningful comprehension, the learners must relate the vocabulary and concepts presented in the reading material to their preexisting knowledge called 'schemata' (Burns, Roe, & Ross, 1999). The schema theory is usually associated with reading comprehension and not with word recognition and decoding of its meaning. It is because in general comprehension, the word in combination with other words in the sentence or passage unfolds the meaning. However, in content comprehension, especially in science and technology, a mere understanding of the word leads to the explanation or comprehension of the definition or the whole passage. For example, cognitive learning of the word *lever* would automatically lead the student to understand the concept of 'levitating magnet' in physics, because both the words are derived from the same Latin root *lev* meaning 'light in weight'.

The schema theory advocates use of graphic organizers or any other pre-reading strategy to provide prior knowledge and the same can be done to recognize a word, decode its meaning and associate with the content for better comprehension. Graphic organizers in the form of written or graphic presentations assist the students in becoming familiar with new vocabulary and concepts enabling them to understand and retain information garnered from the text reading. Just like concept mapping (Cassidy, 2011), semantic, etymological and morphological mappings can be applied in any academic discipline to make a better sense of reading and cognitive learning. In fact, teaching of word-learning strategies is considered essential for vocabulary acquisition to enable students to figure out the meaning of words when reading independently (Graves, Schneider, & Ringstaff, 2017) and explicit teaching of vocabulary has been proved to be more effective than implicit teaching (Hansen, 2009; Mazban & Kamalian, 2013; Zarei & Sepahian, 2015). In this background the present study assumes significance because CVL strategies have been devised and used to build the schema for learning content words in ESP by L2 learners who do not share the same L1.

3.2. Cognitive strategies in VLS

Schmitt's (1997) taxonomy of VLS, which was based on Oxford's (1990) classification of Language Learning Strategies (LLS), has been the most influential one until now and Catalán (2003) recommends the use of Schmitt's taxonomy for research as it is based on the theories of LLS and the theories of memory. Schmitt (1997) introduced cognitive strategies in his taxonomy and they are:

- Verbal repetition
- Written repetition
- Use of wordlist
- Use of flash cards
- Taking notes in class
- Use of the vocabulary section in text book
- Listening to audio recordings of vocabulary lists
- Putting English labels on physical objects
- Keeping a vocabulary notebook

As mentioned earlier, these strategies do not involve mental processing of information. Schmitt has mentioned 'semantic mapping' but has placed it under the category of memory. After conducting a study in Japan he reported that 'mature' respondents found useful the strategies involving 'deeper' processing and greater cognitive effort.

The framework for developing cognitive strategies involving deep processing is provided by the Dual Code Theory (DCT) and the Level of Processing Model of Memory. Clark and Paivio (1991) present Dual Code Theory as a general framework for educational psychology. Dual Coding Theory (Clark & Paivio, 1991; Paivio, 1986, 2006) suggests that learning is enhanced by complementary sources of information that are received simultaneously, such as a picture and text, and that the memory consists of two representational processes for both pictorial and verbal information that function independently but interact, enhancing retention and retrieval (Mayer, 2009). Cohen and Johnson (2011) studied the effect of dual coding and image creation in learning of novel words by second grade students and found that the imagery intervention facilitated learning of new words. According to DCT, when a verbal stimulus invokes non-verbal thought and vice versa, the words and images are encoded together creating a stronger memory trace.

As an established theory of general cognition, DCT has been applied to literacy and in spite of abundance of research in DCT and its applications, it has not been explored fully in the use of building vocabulary of ESP learners in a robust form. The words in specialist word lists like ESWL are technical and semi-technical having classical roots. Hence, the use of etymology and semantic grouping as vocabulary building strategies give ample scope for creating mental images.

Craik (2002) proposed that semantic analysis or 'deep' processing is associated with higher levels of retention and clarified that deep processing requires more attention and not more time. According to this model, stronger memories occur as a result of a deep memory trace which happens through 'elaborative rehearsal' that takes place in the mind at the time of learning. Henning (1973) earlier stated that high proficiency learners register vocabulary by semantic similarity. The elaborate process of learning as evinced by the use of CVL that requires either a diachronic perspective to unravel the meaning and / or form of a word or semantic or structural elaboration leads to a strong memory trace. It complements teaching of synchronic aspect of word knowledge that is normally practiced in classrooms. The 'word processing' or 'elaborative rehearsal' does not provide only the lexical knowledge but the key to comprehending the text in which the word occurs. Perfetti and Stafura (2014) endorse this view when they say that within the Reading System Framework, there is a close interaction between the word identification system and the comprehension system that is mediated by lexical knowledge. The lexical knowledge can be enriched by mental processing of word meanings. But CVL is not being practiced as the main vocabulary building strategy in classrooms due to time constraint though it is occasionally used by both language and content teachers spontaneously. For example, the chapter in Nanotechnology in Engineering Chemistry opens with the etymological explanation of the word *nano*. Such occurrences are rare in science text books. Hence, with the introduction of corpus based curriculum, compilation of wordlists and availability of programs like 'Concordance', CVL has the potential to become the leading vocabulary building strategy in ESP classrooms.

4. METHODOLOGY

4.1. The experimental study

The experimental study to find out the outcome of CVL was conducted among eighty students of first year engineering programme of a university in India. Since the admission to colleges in universities is arranged through pooled allotment based on either the common admission tests or class XII marks and the ranking of colleges released by the All India Council of Technical Education (AICTE), the groups are homogenous. Forty students of Bioengineering branch constituted the control group and 40 students of Civil engineering branch constituted the experimental group. Pre-tests were conducted at the beginning of the course study and post-tests at the end of a three-month period.

The test design for the study was chosen keeping in mind that vocabulary knowledge is a multidimensional construct and both the breadth and the depth of vocabulary knowledge should be tested. Earlier researchers (Bardakçı, 2016; Rashidi & Khosravi, 2010; Zhang & Koda, 2017) have used a similar design for their studies. The first section of the test followed the pattern of the Vocabulary Size Test (VST) designed by Nation and Beglar (2007). It is reliable as the various versions of the test have been piloted by Nation himself. In this pattern, the word to be tested was given in a non-defining sentence and the meaning of the word was to be chosen from the options given below. The options belonged to the same or higher frequency level in comparison to the target word. An example is given below:

Q. **Intermittent**: I hear an **intermittent** noise.

a. Audible
b. Discontinuous
c. Distant
d. Feeble

The second section tested the depth of vocabulary knowledge (DVK) and the questions were framed on the pattern of the Word Association Test developed by Read (1998). Depth of vocabulary knowledge means the knowledge of the word's formal features, syntactic functioning, collocational possibilities and register characteristics (Read, 2004: 153). Twenty-five words given in adjectival forms were used to assess two aspects of vocabulary depth – meaning and collocation. Eight options were given in two groups for each word. The first four words were in adjectival forms forming a paradigmatic relationship with the target word. The second four words were in noun forms forming a syntagmatic relationship by collocating with the target word. Thus for each question four answers were possible. An example is given below:

Microscopic	1) orderly	2) novel	5) circuit	6) assembly
	3) minute	4) lively	7) structure	8) organism

The RC comprised three passages; one was taken from Engineering Chemistry text book, one from Engineering Physics text book and one from the National Programme on Technology Enhanced Learning lecture series meant for the first semester students of engineering. The content validity was checked by two professors of the same university and one from University of Technology, Sydney, Australia. All the questions were multiple choice questions to be answered in 45 minutes. Both groups were given the tests on the same day.

4.2. Intervention

The experimental group was given intervention of 30 sessions of half-an-hour each for a period of three months. The ESWL containing 1,272 words were given to the students. The words were arranged as they occur in the frequency bands of 1,000 words each, from high frequency to low frequency (1K to 25K) using 'vocabprofile' which was based on the lists created by Nation (2012) from British National Corpus-Corpus of Contemporary American (BNC-COCA) English. The words in the frequency band >25 were listed as 'off list' words. There were 43 'off list' words in the list. The arrangement helped in focusing on mid (4K-9K) and low frequency words (beyond 9K) during the intervention sessions. The principles of etymology, semantics and affixes were explained with examples to the students.

In etymological analysis, the diachronic perspective of word origins and evolution of word meanings gave ample scope for posturizing or visualizing the meaning as described in the Dual Code Theory. For example, when the meaning of the root *dia-* as 'across' was visualized, it became easy to guess and find the meanings of the words like *diameter*, *diagonal*, *diastolic*, *diaphragm*, and *dialysis*. A sample 'web of words' in which the words are added according to the shared root is given in Appendix 1.

Semantic mapping was done with the help of graphic organizers that involved a lot of creativity. The aim was to visually present meaning-based connections between words in relation to concepts. Students were encouraged to group words on the basis of affixes, meaning, concept or context. A sample is given in Figure 1.

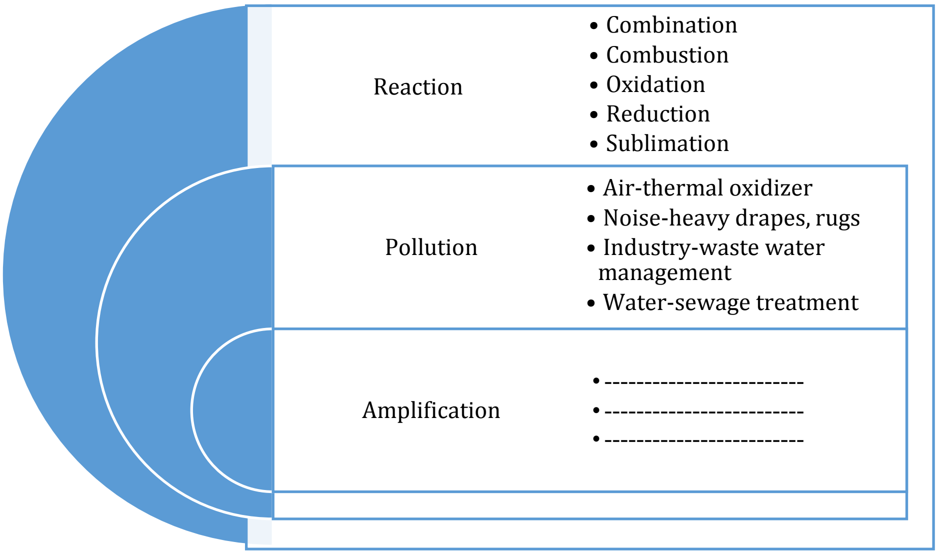

Figure 1. Semantic grouping of words ending in –*tion*

Prefixes and suffixes could be explained etymologically, but there are some affixes that follow scientific practice and norms set up by the IUPAC (International Union of Physical and Applied Chemistry) and hence fall beyond the purview of linguistic analysis. For example, the suffix *–loid* (*eidos* in Greek means 'shape' or 'form') can be linguistically analyzed to help decoding the meaning of other words ending in *–loid*, like *colloid*, *crystalloid*, *metalloid*, *alkaloid*, *cycloid*, etc. However, the suffixes *–ose*, *–ol*, *-ane*, *-ene*, etc. follow scientific conventions only. For example:

-*ose*	sugar based	glucose, sucrose, etc.
-*ol*	alcohol based	methanol, ethanol, etc.
-*ane*	single bonded carbon atoms	methane, butane, etc.
-*ene*	double bonded carbon atoms	propene, ethene, etc.

The intervention sessions focused mainly on the three strategies discussed above. A few passages from the text books of engineering science were given for reading comprehension where the students were encouraged to apply their CVL strategies to decode the meaning of the content words and understand the text. A sample of vocabulary learning strategy integrated with reading comprehension is given in Appendix 2.

5. RESULTS

The scores were analyzed using the software SPSS version 23. First, the reliability of the test was established by finding the 'alpha' value after the pre-test. The pre-test and post-test scores were then analyzed for finding the Mean and Standard Deviation. Independent samples *t*-tests and paired samples *t*-tests were also conducted to find out the *t*-value and the *p*-value. Finally, Cohen's *d* was calculated for effect size and *r* was calculated for correlation.

The homogeneity between the groups at the time of pre-test had to be statistically established before further analysis. Hence, the pre-test scores of both groups were compared to find out if there was a difference among the variables of groups. The samples could only be assumed to be homogenous in social sciences, though a preliminary screening was done based on the students' bio data and their grades in the entrance examination. Hence the assumption of homogeneity of variance was tested using Levene's Test of Equality of Variances, which was produced in SPSS Statistics when running the independent *t*-test. If the *p*-value was greater than 0.05 (i.e. $p > .05$), the group variances could be treated as equal. In the current study, the Mean difference in the pre-tests of the experimental and the control groups was 3.475. However, this difference was not significant to the 95% confidence interval as revealed by the figures in Levene's Test for Equality of Variances given in Table 1. The *p*-value in the column "Sig. (2-tailed)" was 0.258, which was greater than 0.05. It indicated that there was no significant difference between the control and the experimental groups and that they were homogeneous.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Diff.	Std. Error Diff.	95% Confidence Interval of the Difference	
									Lower	Upper
Pre-test score	Equal variances assumed	.196	.660	1.14	78	**.258**	3.4750	3.0480	-2.5931	9.5431
	Equal variances not assumed			1.14	77.6	**.258**	3.4750	3.0480	-2.5936	9.5436

Table 1. The independent *t*-test scores of the control and the experimental groups – Pre-test

An independent samples *t*-test was conducted to compare the pre-test scores of the control and the experimental groups. On analysis, no significant difference was found between the pre-test scores of the control (M=93.5, SD=14.10) and the experimental groups (M=90.02, SD=13.14), t (78) =1.14, p = 0.258.

Similar to the pre-test scores, an independent *t*-test was conducted to compare the post-test scores of the two groups and significant difference was found between the two with a high *t*-value of 5.78 and low *p*-value of 0.00. Table 2 shows the values which indicate improvement in the experimental group as the result of the intervention.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Diff.	Std. Error Diff.	95% Confidence Interval of the Difference	
									Lower	Upper
Post-test score	Equal variances assumed	3.513	.065	**5.78**	78	**.000**	14.600	2.5258	9.5714	19.6286
	Equal variances not assumed			**5.78**	68.0	**.000**	14.600	2.5258	9.5597	19.6402

Table 2. The independent *t*-test scores of the control and the experimental groups – Post-test

An independent samples *t*-test was conducted to compare the post-test scores of the control and the experimental groups. On analysis, a significant difference was found between the post-test scores of the experimental (M=112.82, SD=18.87) and the control group (M=98.23, SD=13.28), t (78) =5.78, p<0.05.

The results of pre-tests and post-tests of both the control and experimental groups were further analyzed to find out Means and Reliability for the three sub sections of the test – VST, DVK and RC. All the scores were converted to percentage for the purpose of calculation and comparison. The details are given in Table 3.

Group	Testing	Variables	MPS*	Max	Min.	Mean	Alpha - Reliability
	pre-test	VST	100	100	30	57.5	0.61
	post-test			100	40	78.8	0.79
Experimental	pre-test	DVK	100	91	50	68.5	0.71
	post-test			97	67	83.9	0.72
	pre-test	RC	100	100	20	63.12	0.93
	post-test			100	60	84	0.73
	pre-test	VST	100	100	20	60	0.64
	post-test			100	40	72.2	0.69
Control	pre-test	DVK	100	91	50	70.28	0.75
	post-test			96	51	71.88	0.78
	pre-test	RC	100	100	25	68.92	0.92
	post-test			100	24	76.52	0.87

*MPS - maximum possible score.

Table 3. Scores and alpha (reliability) value of VST, DVK and RC sections of pre- and post-tests.

In a paired sample *t*-test, each group is measured twice, resulting in *pairs* of observations. It is conducted when one group of participants is measured on two different conditions at two different times (like pre-test and post-test) to find if the mean difference between paired observations on a particular outcome is significantly different from zero. A paired samples *t*-test was conducted in the current study to measure the difference between the scores of the post-test and the pre-test of both groups. The *p*-value for both groups was <0.05 indicating significant difference between the two tests.

The finding that both groups showed significant improvement ($p<0.05$) was interesting and further analysis was required to measure the difference in the value of the 'effect size'. The effect size is an indicator of how strong or how important the results are. One common method of indicating effect size is to express the difference in means in terms of standard deviations. Cohen's *d* is commonly used to find the effect size. The formula is:

Cohen's $d = (M_2 - M_1) / SD_{\text{pooled}}$ where $SD_{\text{pooled}} = \sqrt{((SD_1^2 + SD_2^2) / 2)}$.

The following guidelines are used to interpret the effect size *d*:

- $d = 0.2$ is a small effect size
- $d = 0.5$ is a medium effect size
- $d = 0.8$ is a large effect size

The effect size or Cohen's *d* for the total scores and the scores in the sub sections of the experimental group were found to be very large ($d > 0.8$). Table 4 shows that the correlation *r* is positive, *t*-values are high and *d*-values are >0.8 for the experimental group.

Paired samples	*r*	*t*	Cohen's *d*
Post - Pre Total score	0.703	15.43	2.44
Post - Pre Vocabulary score	0.67	12.59	1.99
Post - Pre RC score	0.625	6.95	1.09

Table 4. Results of paired sample *t*-tests and effect size of the experimental group

The increase in the vocabulary scores was correlated with the increase in the RC scores. Figure 2 depicts the increase in vocabulary scores and RC scores of the experimental group in the form of a scatterplot. It can be observed that there has been a rise in both scores; however, the line indicating vocabulary scores shows a steeper rise.

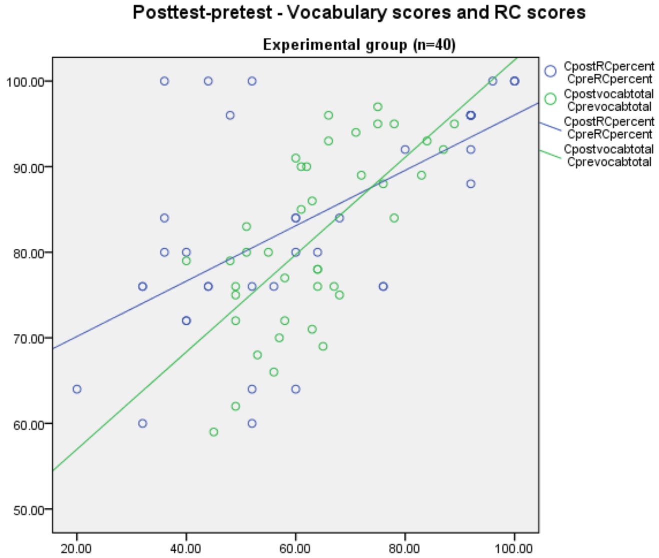

Figure 2. Scatterplot depicting increase in vocabulary and RC scores of experimental group

In figure 3, the VST scores are plotted against the DVK scores. There is a marginal increase in the VST scores of the experimental group, while the increase is steep in the DVK scores of the post-test.

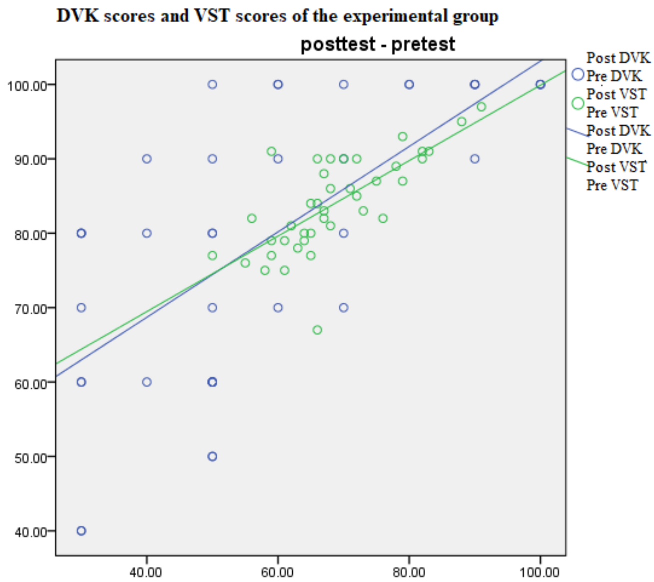

Figure 3. Scatterplot depicting increase in the scores of VST and DVK of experimental group

The reason for the increment in both charts was the effective intervention aimed at building the vocabulary of the students through CVL.

6. DISCUSSION

The aim of this study was to investigate the efficacy of the vocabulary building strategies in ESP to promote comprehension. As discussed in the section on intervention, the learning focus was on both the synchronic and diachronic aspects of word knowledge. Generally, these content words which are very important for comprehending academic texts are ignored by both the English and the content teachers. The English teachers are not aware of the needs of the ESP learners and the ESP teachers do not have linguistic awareness to increase the word knowledge of the learners. But the intervention has proved that the knowledge of a content word gives the knowledge of the concept itself. In other words, the boundary between language knowledge and content knowledge disappeared. A good example is the word *hydrolysis* that occurs frequently in science. The definition given in the book is:

> **Hydrolysis** is the breaking down of a chemical compound into two or more simpler compounds by reacting with water.

Any learner who does not know the etymological knowledge of the word simply memorizes the definition. However, the etymological instruction of the words as

Hydro (water) + lysis (loosening)

led to the understanding of the concept of hydrolysis and revealed the meanings and concepts of other words used in engineering science like *hydraulic*, *hydrophilic*, *hydrophobic*, *hydrous*, *anhydrous*, *hydrate*, *anhydrate*, *hydrostatic*, *hydroscope*, *electrolysis*, *photolysis*, *thermolysis*, *pyrolysis*. Thus the synchronic knowledge of the word provided by the book or any science dictionary was widened by the diachronic knowledge to include many other words. It was evident in the increase in the number of correct responses in the post-test. But, there was also a lurking danger of depending too much on one particular strategy of etymology for decoding the meaning of all the content words as indicated by the results.

The use of etymology as a cognitive strategy has to be done carefully as it cannot be applied to all the words in English. For example, the meaning of the prefix *re*- as 'again' is not valid for the word *resin*. Sometimes too much anxiety to find morphological similarity could be misleading. One of the items in the VST section of the test was based on the word *perspective*. The statement is given below along with the options:

Perspective: Your **perspective** is good.

a. personal appearance
b. way of seeing things
c. group of people who work with you
d. pronunciation

The options that confused the learners were: 'way of seeing things' and 'group of people who work with you'. Many students who chose the word-part 'pers' for decoding the word meaning associated it with 'persons' and opted for the answer 'group of people who work with you'. Only those who chose the word-part 'spect' and associated it with 'seeing' opted for the answer 'way of seeing things'. The students need to be assisted in such cases.

When the students have partial knowledge of words, semantic grouping or establishing semantic relationships between words helps in deeper understanding of the multiple dimensions of word meanings, including polysemy. The inclusion of the word *retort* in the group of laboratory equipment is an example. The general meaning known to the students for the word *retort* is 'reply back'. However, in a laboratory the word *retort* refers to a stand where test tubes are kept. Similarly, the word *converse* used in mathematics has nothing to do with 'conversation'; it means 'the opposite' or 'reverse'. Thus semantic grouping opened up a new vista of word knowledge to L2 learners at the tertiary level, most of whom have had school education in L1.

Therefore, it can be said that the intervention enriched the vocabulary knowledge of the students. The analysis of the sub sections revealed that the increase was more in DVK, where knowledge of both syntagmatic and paradigmatic relations were tested, than VST, where only the receptive vocabulary was tested. The increase in DVK indicates the role played by CVL in developing the understanding of the paradigmatic relationship between words, which was instrumental in enhancing their reading. The VST tested only the receptive vocabulary whereas the DVK tested the productive vocabulary. The increase in the DVK scores was due to both the diachronic and the synchronic study of words, which formed the basis of the CVL strategies introduced during the intervention.

The study proved the efficacy of CVL in improving the knowledge of content words, which in turn enhanced reading comprehension of ESP learners. However, it should be noted that the increase in scores of vocabulary is not proportional to the increase in the scores of RC (Figure 2). Table 4 shows that the t-value and Cohen's d for vocabulary scores (12.59 and 1.99, respectively) were more than those of RC (6.95 and 1.09, respectively). This clearly indicates that while vocabulary is an important indicator of reading comprehension, it is not the only indicator.

It is quite interesting to note that the control group also showed an improvement as the p-value was less than .01 for all the tests, indicating that the normal classroom practices were not totally ineffective. However, CVL effected more improvement in the same period of time. The intervention was part of regular teaching hours and it could be said that the synchronic aspect of word knowledge had been strengthened by the diachronic aspect leading to effective vocabulary learning in ESP classrooms. Thus the study recommends integrating CVL with normal strategies already in vogue to bring substantial improvement in the vocabulary and reading skill of engineering students.

Further, it was observed that the cognitive strategies triggered the development of metacognitive skills of the students. They became more engaged in reading science passages provided at the intervention and they could focus more on comprehending as they became 'experts' in decoding the word meanings. During intervention, students were given hands-on activity of creating etymology trees in which new words were added to branches, semantic cubes with words written on all sides and exploring application of words in 'Concordance' on computer. As a result, many words not in the ESWL cropped up expanding the students' vocabulary more than the expectations of the researcher. There was also a positive feedback from the professors of engineering subjects about the intervention provided in the English classes.

7. CONCLUSION

The study focused on content vocabulary because the burden of ESP vocabulary at the tertiary level is huge for L2 learners from vernacular medium schools and the students are expected to master the language and the content in six months or one semester and write their first university exam. As the results of the study indicate, the trauma of the transition could be alleviated to a great extent by focused learning of content words through appropriate strategies. The present empirical study supports the view of the researchers like Armbruster, Lehr, and Osborn who say that teachers should teach how to use information about word parts to figure out the meanings of words in text to facilitate reading (2001). Compared to traditional learning of vocabulary, CVL offers a wide range of experiences and excitement. The consistent direct instruction and active engagement of the learners provide focus and scope for deliberate manipulation of language to improve learning. Explicit word learning and developing awareness of how to think about possible word meanings will surely make ESP learners better readers and enhance their comprehension. In this process their lexical knowledge is integrated into the mental model created by understanding of the text, strengthening, updating and tuning the comprehension process for complete understanding, which is the essence of learning that will lead to academic success.

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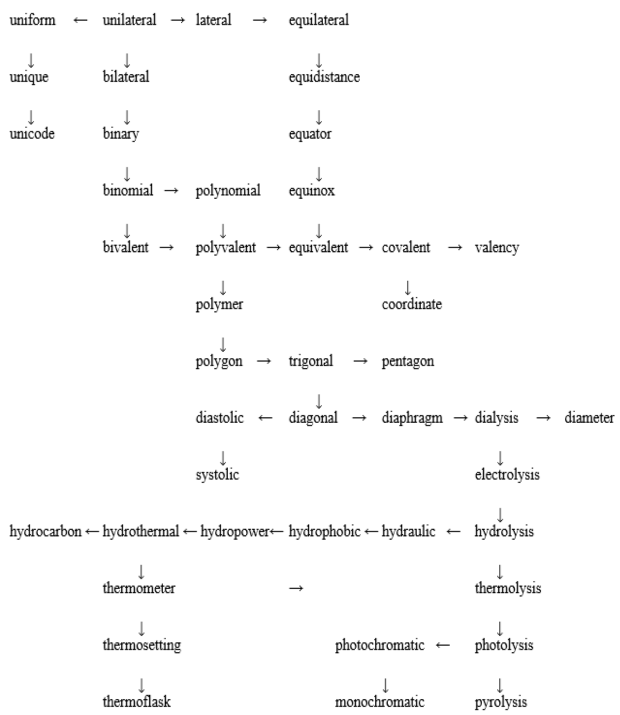
Appendix1

Mind mapping – Web of words

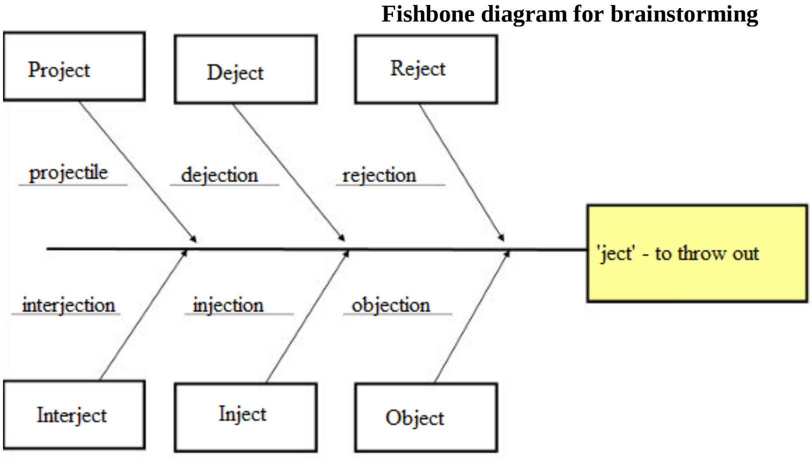


Appendix 2

A sample of vocabulary learning strategies integrated with reading comprehension

Topic: Projectile motion (Engineering Physics)
Vocabulary – Words sharing the root *ject*

Fishbone diagram for brainstorming



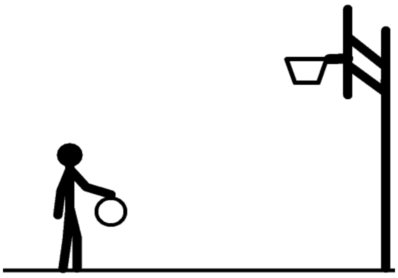
Reading Comprehension
Content generation in engineering physics for 1st semester and 2nd semester engineering students (http://www.gistrayagada.ac.in/PHYSICS-StudyMaterial.pdf)

PROJECTILE MOTION
Definition & Concept:
A body projected into space and is no longer provided with any fuel is called projectile and motion of the body is said to be projectile motion. A projectile can be thrown into all possible directions into the 3D space, which is categorized into three parts,
1. along vertical direction.
2. along horizontal direction.
3. along any direction making an angle of θ with horizontal.

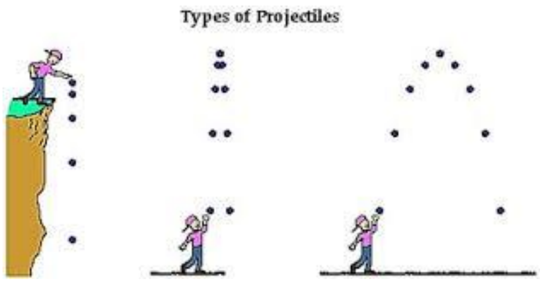
When the projectile is thrown towards the gravitational force of earth, acceleration of the object is equal to the value of acceleration due to gravity. When it is thrown opposite to force of gravity, acceleration of the object is negative of the value of acceleration due to gravity. When the projectile is thrown in any direction making an angle θ with the horizontal, its motion can be considered as the resultant of horizontal and vertical motion.

Examples:
Projectile is a body thrown with an initial velocity in the vertical plane and then it moves in two dimensions under the action of gravity alone without being propelled by any engine or fuel. Its motion is called projectile motion. The path of a projectile is called its trajectory.
Examples:
1. A packet released from an airplane in flight.
2. A golf ball in flight.
3. A bullet fired from a rifle.
4. A jet of water from a hole near the bottom of a water tank.
A body can be projected in three ways.
i. Vertical Projection – When the body is given an initial velocity in the Vertical direction only.
ii. Horizontal projection – When the body is given an initial velocity in the horizontal direction only.
iii. Angular projection – When the body is thrown with an initial velocity at an angle to the horizontal direction.

A few questions taken from the students' worksheet are given below.



1. Draw the trajectory of the ball that would be thrown into the basket.
2. What kind of projectiles are these? (Vertical / Horizontal / Angular)



(a) ---------------- (b) --------------- (c) ------------------

3. What are the requisites of Projectile motion?
    A. sustained velocity
    B. initial velocity
    C. a ball
    D. fuel

a. only A
b. only B
c. B, D, and C